Missouri Department of Natural Resources
Water Pollution Control Program

Total Maximum Daily Loads (TMDLs)

for

Rock Creek
Jefferson County, Missouri

Completed July 21, 1999
Approved December 1, 1999

Rock Creek (Missouri) Final TMDLs (Total Maximum Daily Loads) for CBOD and Ammonia (two TMDLs total)

Name: Rock Creek

WBID No.: 1714 Class: P[1]

Beneficial uses: Livestock and wildlife watering; Warm water aquatic life and human health – fish consumption.

Size of Impaired Segment: 2 miles

Location of Impaired Segment: Portion from Seckman Valley WWTP outfalls which are about 0.20 miles before the confluence with Black Creek to the confluence with the Mississippi River

Pollutants: BOD and Ammonia

Pollutant Sources: West Elm Place WWTP (MO 0087165) and the IUC, Seckman Valley WWTP (MO 0087629)

TMDL Priority Ranking: High

1. Description of Waterbody, Pollutant of Concern, Pollutant Sources and Priority Ranking

Rock Creek is listed on the 1998 303(d) list due to high BOD (which causes low dissolved oxygen) and high ammonia resulting from discharges from the two wastewater treatment plants, West Elm Place and Imperial Utility Corp (IUC), Seckman Valley. The TMDL priority ranking for Rock Creek is high. Frequent violations of Water Quality Standards for dissolved oxygen and ammonia have occurred in Rock Creek. Effluent violations occur during dry weather conditions when the stream flow is effluent dominated. For this reason TMDLs are calculated at critical low flow conditions (7Q10) when effluent violations are prevalent.

Rock Creek originates 3 miles upstream of where Highway 21 crosses the stream. It flows southeasterly for 11 miles and drains into the Mississippi River. The uppermost section of Rock Creek is unclassified. The upper classified section of Rock Creek is defined as Class C[2] and extends 3 miles from where Rock Creek crosses Highway 21 down to where it becomes a Class P stream in Seckman. The Class P stream is 5 miles long. The 2-mile section that is impaired is within the Class P stretch of Rock Creek and starts at the Seckman Valley WWTP

[1] Class P – streams that maintain permanent flow even during drought periods.
[2] Class C – streams that may cease to flow in dry periods but maintain permanent pools which support aquatic life.

outfall, which is about 0.20 miles upstream of the confluence with Black Creek and extends to the Mississippi River.

Black Creek, 4.4 miles long, is a tributary of Rock Creek, and is unclassified through its entire length.

The 7Q10 of Rock Creek has not been determined but is estimated at 0.1 cfs (cubic feet per second) just upstream of the Seckman Valley Lagoons. Missouri Standards (10 CSR 20-7.031 at 5.B.I) provides maximum size of mixing zones for flows between zero and 0.1 cfs. During dry weather conditions there is no flow in Black Creek above the West Elm Place WWTP and the 7Q10 is considered zero. Flow below the facility is effluent-dominated but Black Creek is also considered a gaining stream.

The physiographic setting of Rock Creek is characterized by Mississippian-aged limestone in the upper portion of the subwatershed and Ordovician rocks, predominantly shales and limestone underlie the lower part of the basin. Portions of the upper reach of Rock Creek between Highway 21 and the community of Seckman are considered to be a losing stream. Rock Creek downstream of Seckman is considered to be a gaining stream. Missouri Standards (10 CSR 20-7.031 at 11) specifically addresses facilities located on losing streams. Downstream of Seckman, Rock Creek intercepts portions of the Decorah Shale formation and at these locations receives surcharging ground waters.

The shale and limestone in the lower reaches of Rock Creek, particularly between Seckman Lagoons and the town of Kimmswick, is highly weathered giving rise to Karst topography.

Black Creek is developed over Mississippian limestone in the upper subwatershed and in the lower reaches it is developed over limestone, shale and sandstone. Black Creek is wholly contained in Karst topography but is considered to be a gaining stream.

There are three point sources that discharge directly into Rock Creek and one point source that discharges into Black Creek. Facilities that discharge into Rock Creek include IUC, Country Club Manor WWTP (MO-0093611); IUC, Seckman School WWTP (MO-0099864); and IUC, Seckman Valley WWTP (MO-0087629). West Elm Place, Black Creek WWTP discharges into Black Creek. Due to population increase, these facilities discharge effluent near or above design capacity. Water Quality Standards are violated during low flow conditions when there is little or no dilution of effluent with stream water.

The 1992 studies by DNR determined that Seckman Valley WWTP was discharging treated wastewater with CBOD-5 and Ammonia averaging 32 mg/l and 20 mg/l, respectively. Self-monitoring data reported by the facility for January 1995 to February 1996 showed a CBOD-5 average of 19mg/l. DNR’s assessment is that according to design parameters, this facility is organically overloaded and needs to be upgraded before the plant can accept more sewer connections. As discussed in the implementation plan, below, DNR’s solution to effluent overload is to close the wastewater treatment plants and route the discharge to a regional wastewater treatment plant.

The following is a description of each point source.

Imperial Utilities Corporation (I.U.C.) – Country Club Manor WWTP. This is the uppermost facility along Rock Creek. It consists of a lift station and aerated lagoons and has a design population equivalent of 477 and a design flow of 0.038 MGD (0.06 cfs). Flow measurements made in July and October 1992 were approximately 0.22 cfs and 0.20 cfs, respectively. These discharges were well in excess of the facility design flow. This facility is very small and does not contribute a significant load to Rock Creek. There is no effluent data for this facility.

I.U.C. – Seckman School WWTP. This facility consists of a three-cell lagoon and lift station. It serves a nearby public school and has a design population of 223 and a design flow of 0.022 MGD (0.03 cfs). The facility did not discharge at either the July or October 1992 sampling events. This facility is very small and does not contribute a significant load to Rock Creek. There is no effluent data for this facility.

I.U.C. – Seckman Valley WWTP (I-55 Sewage Treatment Plant). This facility discharges into Rock Creek and is 0.20 miles upstream of the confluence with Black Creek. It is a two-cell aerated lagoon with a design flow of 0.048 MGD (0.07 cfs). The actual flow at the time of sampling was 0.086 MGD (0.133 cfs). This was twice the allowed discharge level. During the 1992 studies by DNR this lagoon was discharging treated wastewater with both BOD5 averaging 32 mg/l and ammonia 20 mg/l. Self monitoring data reported by the facility from January 1995 to February 1996 shows BOD5 averages 19 mg/l and TSS averages 12 mg/l. Abundant sewage fungi were observed below the discharge pipe up to 20 yards downstream. During both the July and October sampling events, greenish yellow effluent was being emitted and there was a strong hydrogen sulfide odor present.

West Elm Place – Black Creek WWTP. This consists of a lift station, two contact stabilization plants, each with its own outfall discharging into Black Creek, a sludge holding tank and a sludge filter press. The combined design Population Equivalent (P.E.) is 15,000 people with a design flow of 1.5 MGD (2.33 cfs). The actual dry weather flow is approximately 1.10 MGD (1.71 cfs). The July and October flows were 0.859 MGD (1.33 cfs) and 0.801 MGD (1.24 cfs), respectively. Studies conducted by DNR in 1992 and 1995 established that the effluent CBOD-5 was less than 10 mg/l and ammonia nitrogen ranged between 5 and 9 mg/l. Self-monitoring data by the facility for January 1995 through February 1996 showed CBOD-5 average of 17 mg/l and TSS 12 mg/l.

Only the last two facilities contribute BOD and Ammonia to the impaired portion of Rock Creek. A complete description of facilities and instream monitoring sites including data collected during the July 1992 sampling events is given in Appendix I.

These waterbody segments were modeled using the Qual2E model. The first step was to calibrate the hydraulic portion of the model. The lack of USGS gauging stations in the vicinity of Rock Creek or its tributaries necessitated several flow, stream width and stream depth measurements to be made in April 1992. Measurements were made every 200 feet along Rock Creek and Black Creek to allow for the construction of a hydraulic model. Furthermore, water quality surveys and effluent discharge studies were done in July and October 1992. These studies permitted the calibration of the water quality portion of the model. An additional water quality study was conducted in July 1995 to verify the model.

The original 1992 model simulated DO, CBOD5 and ammonia very well and also performed fairly well with 1995 data. Qual2e output files and accompanying graphs are attached.

The calibrated model was used to predict water quality conditions within the mixing zone and just beyond the mixing zone along Rock Creek. The rationale was to determine maximum effluent strengths which would result in the achievement of instream water quality standards for DO and ammonia. The prognosis based on simulated results is that instream dissolved oxygen standards during 7Q10 low flow conditions can barely be achieved with stringent CBOD5 limits. It is questionable if the two facilities can meet the water quality standards even with a high degree of treatment.

A phased TMDL approach will be used. Advanced waste-water treatment may be sufficient for the instream water to meet applicable water quality standards. The facilities have the option to upgrade; however, if after any upgrade instream monitoring shows that standards are not met, the permits will require implementation of even more stringent effluent limits capable of meeting Water Quality Standards or the elimination of these discharges. Based on conversations with the utility companies involved, Missouri believes all the discharges will be eliminated, and then all applicable state Water Quality Standards will be met.

2. Description of the Applicable Water Quality Standards and Numeric Water Quality Target

Designated Uses: Rock Creek has beneficial uses that include livestock and wildlife watering, fish consumption and protection of aquatic life.

Ammonia:
Missouri's Water Quality Standards, 10CSR20-7.031 Table B, lists the chronic ammonia limits for general warm water fisheries such as Rock Creek. These limits are pH and water temperature dependent. Seasonal ammonia limits and the typical seasonal pH and water temperature values are given in Table 1.

Table 1: Instream Criteria

	Within Mixing Zone	*Beyond Mixing Zone*
Dissolved Oxygen (mg/l)	*3.0*	*5.0*
Ammonia (mg/l), June-September (pH 7.8, Temperature 26° C)	*14.0*	*1.2*

Ammonia (mg/l), October-May (pH 7.8, Temperature 8° C)	*16.0*	*2.0*

CBOD:
There is no numeric criterion in the water quality standards for CBOD. Since the effect of CBOD is to exert oxygen demand on the receiving waterbody, dissolved oxygen is the surrogate indicator for BOD or CBOD. Missouri considers BOD and CBOD to be sufficiently equivalent to be used interchangeably in these TMDLs, since CBOD is the more dominant process and is what is measured in BOD5. There is only about 5 mg/l more or less difference between CBOD and BOD. However, in QUAL2E model simulation of DO, both carbonaceous and nitrogenous BOD is factored into the model. State water quality standards call for maintenance of 5 mg/l or the normal background level of dissolved oxygen, whichever is lower. The DO limits are provided in Table 1.

Anti-degradation policy

Missouri's water quality standards include the EPA "three-tiered" approach to anti-degradation.

Tier I defines baseline conditions for all waters -- it requires that existing beneficial uses are protected. TMDLs would normally be based on this tier, assuring that numeric criteria (such as dissolved oxygen, ammonia) are met to protect uses.

Tier II requires no degradation of high-quality waters, unless limited lowering of quality is shown to be necessary for "economic and social development". A clear implementation policy for this tier has not been developed, although if sufficient data on high-quality waters are available, TMDLs could be based on maintaining existing conditions, rather than the minimal tier I criteria.

Tier III (the most stringent tier) applies to waters designated in the water quality standards as outstanding state and national resource waters; tier III requires no degradation under any conditions. Management may require no discharge or prohibition of certain polluting activities. TMDLs would need to assure no measurable increase in pollutant loading.

These two TMDLs will result in the protection of existing beneficial uses, which conforms to Missouri's Tier I anti-degradation policy.

3. Loading Capacity – Linking Water Quality and Pollutant Sources

The loading Capacity is the greatest amount of pollutant loading that a stream can take without becoming impaired.

Load Capacities for streams with wastewater dischargers depends on the flow of the stream. Since the load from the wastewater discharger is more or less constant, water quality standards exceedances are most likely to occur at low flow conditions. These critical conditions are called the design stream flow. The Load Capacity for the impaired portion of Rock Creek were calculated using the low flow condition as follows:

Ammonia

(Design stream flow in cfs)(Ammonia concentration from WQ standards)(5.4)= Pollutant capacity of the stream in pounds per day. *(1)*

The design flow for the impaired section of Rock Creek is the sum of the 7Q10 low flow of Rock Creek just upstream of the Seckman Valley WWTP (0.1 cfs), plus the design flow of the two WWTPs (1.16 cfs for Seckman Valley and 2.32 cfs for the WEP Black Creek plant). This design flow is 3.58 cfs. The instream chronic ammonia standard for Rock Creek at typical water temperature and pH is 1.2 mg/l summer and fall, 2.0 mg/l winter and spring. Using Formula 1, the Load Capacity at the end of the mixing zone for ammonia is 23.20 #/day summer/fall and 38.66 #/day winter/spring.

CBOD

(Design stream flow in cfs)(CBOD concentration at which DO conc. from WQ standards is achieved)(5.4)= CBOD capacity of the stream in pounds per day. *(2)*

The design flow of 3.58 cfs was used to calculate the load capacity for CBOD. The LC value is based on the highest instream concentration of CBOD predicted by the model at which in stream water quality standards for DO concentration are met, the point at the end of the mixing zone. The CBOD value (0.9 mg/l) was derived from Qual2E model estimation at end of the mixing zone (mile 8.2) and the end-of-pipe load capacity of CBOD was calculated at 17.4 #/day in summer and 48.3 #/day in winter.

4. Load Allocations

Missouri is establishing the load allocations under the critical flow conditions as the actual nonpoint loading to the segment. The Load Allocation is the term used for the nonpoint source pollutant load and is calculated using Formula 3.

(7Q10 stream low flow in cfs)(background instream pollutant concentration at the 7Q10 low flow in mg/l)(5.4)= pollutant load in #/day.
(3)

There is no flow in Black Creek other than the wastewater discharge at the 7Q10 low flow and thus there is no ammonia or CBOD load allocation for Black Creek. 7Q10 low flow for Rock Creek is 0.1 cfs, and during field studies ammonia concentrations upstream of the Seckman Valley WWTP were consistently measured as less than the detection limit (0.05 mg/l). Taking the concentration as one-half the detection limit, the ammonia load allocation is:

(0.1cfs)(0.025 mg/l)(5.4)= 0.01 #/day

Likewise, the Load Allocation for BOD is established as the actual background loading, and is calculated using Formula 3. The background concentration of BOD is zero, so the Load Allocation for BOD is zero pounds per day.

5. Wasteload Allocation

The CBOD wasteload allocation is based on the results of the qual2e modeling. The ammonia wasteload allocation is based on the observed decay rate of ammonia in the mixing zone.

CBOD wasteload allocations:

The total CBOD wasteload allocation is established as the loading capacity as determined using the qual2e model at the WWTP discharge minus the margin of safety minus the load allocation (which is zero). This total wasteload allocation is then divided between the two facilities based on flow. The total wasteload allocations are:

	(loading capacity) - (MOS) - (load allocation) = wasteload allocation
Summer:	(17.4 #/day) - (3.48 #/day) - (0) = 13.9 #/day CBOD end-of-pipe
Winter:	(48.3 #/day) - 3.48 #/day) - (0) = 44.8 #/day CBOD end-of-pipe

Dividing this total wasteload to the individual facilities based on flow gives:

Summer:	Seckman Valley WWTP (13.9 #/day) * (.33) = 4.6 #/day CBOD end-of-pipe
	WEP Black Cr. WWTP (13.9 #/day) * (.67) = 9.3 #/day CBOD end-of-pipe
Winter:	Seckman Valley WWTP (44.8 #/day) * (.33) = 14.8 #/day CBOD end-of-pipe
	WEP Black Cr. WWTP (44.8 #/day) * (.67) = 30 #/day CBOD end-of-pipe

Ammonia wasteload allocations:

The actual loading from the point source pollutant load is calculated using Formula 4. The very small facility discharges are ignored. Since there is no effluent data for Seckman Valley WWTP, that effluent concentration is assumed to be the same as West Elm Place WWTP. The data shows that ammonia nitrogen ranged between 5 and 9 mg/l, so 7 mg/l was selected:

(Design flow of WWTP in cfs)(average effluent pollutant concentration in mg/l)(5.4)= pollutant #/day)

(4)

Using this formula, the actual ammonia loadings are:

WEP Black Cr. WWTP all seasons:	(2.32 cfs)(7 mg/l)(5.4)=	87.7 #/day
Seckman Valley WWTP all seasons:	(1.16 cfs)(7 mg/l)(5.4)=	43.8 #/day

For a total existing end-of-pipe ammonia loading of 131.5 #/day. This number will be used later when calculating the percent reduction required to meet water quality standards.

<u>Instream Ammonia Losses Between WWTP outfalls and the point on Rock Creek where Chronic Ammonia Standards are Required</u>

The point on Rock Creek where chronic ammonia criteria become required is 0.2 miles downstream of the Seckman Valley WWTP and 1.75 miles downstream of the Black Creek WWTP. Formula 4 shows the calculation of these losses:

(Ammonia decay rate mg/l per mile)(Distance in miles between outfall and stream point where chronic criteria must be met)(stream flow at 7Q10 low flow in cfs)(5.4)= ammonia losses #/day

(5)

During field studies, ammonia decay rates in Black Creek were estimated based on instream measurements to be approximately 4 mg/l per mile in summer and 2 mg/l per mile in winter. Accounting for the uncertainty in these estimated decay rates, calculation of instream ammonia losses in this TMDL uses the conservative decay rates of 2.0 and 1.2 mg/l per mile for summer and winter respectively in Black Creek and thus contributes to an inherent margin of safety. Rock Creek ammonia decay rates were similar to most other effluent dominated Missouri streams and were estimated at approximately 1 mg/l per mile in summer. Winter ammonia decay studies were not made on Rock Creek but winter ammonia decay in Rock Creek is estimated at 0.8 mg/l per mile. These decay rates would normally be modeled by an exponential decay function, and the model provides a calculated decay at the end of the mixing zone given the distance or time from the discharge to the end of the mixing zone. In this TMDL, the exponential model was not needed because the decay for this segment was obtained by actual measurements at the ends of the mixing zone. Thus the actual instream ammonia losses are calculated as:

Summer:

Black Cr.	(7 mg/l) - (1.0 mg/l/mi)(1.75 mi) =	5.25 mg/l NH_3 at end of mixing zone
Rock Cr.	(7 mg/l) - (1.0 mg/l/mi)(0.25 mi) =	6.75 mg/l NH_3 at end of mixing zone

Winter:
Black Cr. (7 mg/l) - (0.8 mg/l/mi)(1.75 mi) = 5.6 mg/l NH3 at end of mixing zone
Rock Cr. (7 mg/l) - (0.8 ml/l/mi)(0.25 mi) = 6.8 mg/l NH3 at end of mixing zone

The instream criteria for ammonia beyond the mixing zone is 1.2 mg/l in summer and 2.0 mg/l in winter. The existing end-of-mixing-zone winter ammonia concentrations of 5.6 and 6.8 mg/l respectively will have to be reduced to 1.2 and 2.0 mg/l respectively.

The actual ammonia end-of-mixing-zone load after instream decay is then:

Summer:		
WEP	(2.32 cfs)(5.25 mg/l)(5.4) =	65.8 #/day
Seckman Valley	(1.16 cfs)(6.75 mg/l)(5.4) =	42.3 #/day
Total		108.1 #/day
Winter:		
WEP:	(2.32 cfs)(5.6 mg/l)(5.4) =	70.1 #/day
Seckman Valley:	(1.16 cfs)(6.8 mg/l)(5.4) =	42.6 #/day
Total		112.7 #/day

In order to attain water quality standards at the end of the mixing zone, the summer load of 108.1 pounds per day and the actual winter load of 112.7 pounds per day must be reduced to a loading that will meet water quality standards. That target is the loading capacity minus the margin of safety minus the load allocation. This is summarized as follows:

Summer: (23.2 #/day) - 4.64 #/day) - (.01 #/day) = 18.56 #/day NH3 after mixing zone
Winter: (38.66 #/day) - (7.73 #/day) - (.01#/day) = 31.43 #/day NH3 after mixing zone

The percentage of the actual load that meets water quality standards is the wasteload allocation. This percentage beyond the mixing zone is:

Summer: (18.5 #/day) / (108.1 #/day) * 100% = 17%
Winter: (31.43 #/day) / (112.7 #/day) * 100% = 28%

The required percentage of the actual load beyond the mixing zone equals the required percentage at the end of the pipe. The total wasteload allocation at the end of the pipe is:

Summer: (131.5 #/day) * (.17) = 22.4 #/day NH3 as N total end-of-pipe
Winter: (131.5 #/day) * (.28) = 36.8 #/day NH3 as N total end-of-pipe

This total wasteload allocation figured at the end of the pipe is divided between the facilities based on flow, giving the wasteload allocations for each individual facility:

Summer: WEP Black Cr. WWTP (.67) * (22.4 #/day) = 15 #/day NH3 as N end-of-pipe

Seckman Valley WWTP (.33) * (22.4 #/day) = 7.4 #/day NH3 as N end-of-pipe
Winter: WEP Black Cr. WWTP (.67) * (36.8 #/day) = 24.6 #/day NH3 as N end-of-pipe
Seckman Valley WWTP (.33) * (36.8 #/day) = 12.1 #/day NH# as N end-of-pipe

6. Margin of Safety

The margin of safety accounts for the uncertainty of our understanding about how the waterbody responds to the parameter being measured..

There is insufficient data to determine the uncertainty of the loading capacity of Rock Creek for both ammonia and BOD. Therefore, the margin of safety for both ammonia and CBOD5 were estimated at 20% . The margins of safety are:

Ammonia (summer/fall): (23.2 #/day)(0.2) = 4.64 #/day
Ammonia (winter/spring): (38.66 #/day)(0.2) = 7.73 #/day
CBOD: (17.4 #/day)(0.2) = 3.48 #/day

7. Seasonal variation

Seasonal variation for instream chronic ammonia standard is calculated at typical seasonal water temperature and pH. For Rock Creek, an ammonia concentration of 1.2 mg/l was used for summer and fall conditions (pH 7.8, temp. 26° C) and a value of 2.0 was applied to winter and spring conditions (pH 7.8, temp. 8° C).

Qual2E was the model used to provide steady state simulation of flow, dissolved oxygen, CBOD-5 and ammonia, and the results used to establish the seasonal CBOD loading capacities.

8. Monitoring Plan for TMDLs Developed Under the Phased Approach

Two 24-hour water quality studies of Rock Creek during summer low flow conditions will be conducted the first year after both these facilities have completed any upgrades.As discussed below, it is expected that the discharging facilities will be closed. As a result of the elimination of all discharges, the applicable water quality standards will be met.

9. Implementation Plans

These two TMDLs will be incorporated into Missouri's Water Quality Management Plan. These are phased TMDLs. As pointed out above there is little likelihood that the Seckman Valley WWTP and Black Creek WWTP can meet the stringent effluent limits required by the waste load allocations established in these TMDLs. The facilities have the option to upgrade in order to meet applicable water quality standards; however, as a matter of course, plans are now underway to have all the facilities along Rock Creek and Black Creek eliminated and their sewer lines connected to the Rock Creek Regional WWTP at Kimmswick within the next three years. The regional facility has been upgraded to treat more influent and it is still being considered for further upgrades to accommodate additions to the sewer plant. The Rock Creek regional facility discharges directly into the Mississippi River. Therefore, allocations to future growth within this segment are zero, since it will be accomodated in practice by relocated discharge to the Mississippi River. As the implementation of these TMDLs will improve the water quality of Rock Creek, they satisfy the Anti-degradation requirements of the Missouri Water Quality Standards.

The following table shows seasonal effluent limits required to meet Water Quality Standards.

Table 4: Effluent Limits

	Season	*Seckman Valley WWTP*	*Black Creek WWTP*
CBOD-5 (mg/l)	*June-September*	*2.0*	*2.5*
CBOD-5 (mg/l)	*October-May*	*10.0*	*10.0*
Ammonia (mg/l)	*June-September*	*2.0*	*2.5*
Ammonia (mg/l)	*October-May*	*10.0*	*10.0*

10. Reasonable Assurances

All the facilities have NPDES permits, which provides the authority to assure that water quality standards will be met and maintained. Once all the wastewater treatment facilities along Rock and Black Creek are eliminated and their sewer lines connected to the Rock Creek regional WWTP at Kimmswick, it is guaranteed that water quality standards will be attained.

11. Public Participation

This water quality limited segment is included on the approved 1998 303(d) list for Missouri. The Missouri Department of Natural Resources developed the TMDL, Division of Environmental Quality, Water Pollution Control Program. The TMDL was placed on public notice from April 16, 1999 to May 21, 1999 and in addition, six public meetings to allow input from the public on impaired waters were held between August 18 and September 22, 1999. No comments pertaining to Rock Creek were received during the public notice or the public meetings.

12. Administrative Record

An Administrative Record for these TMDLs is being maintained by the Missouri DNR.

13. Data and Information Sources

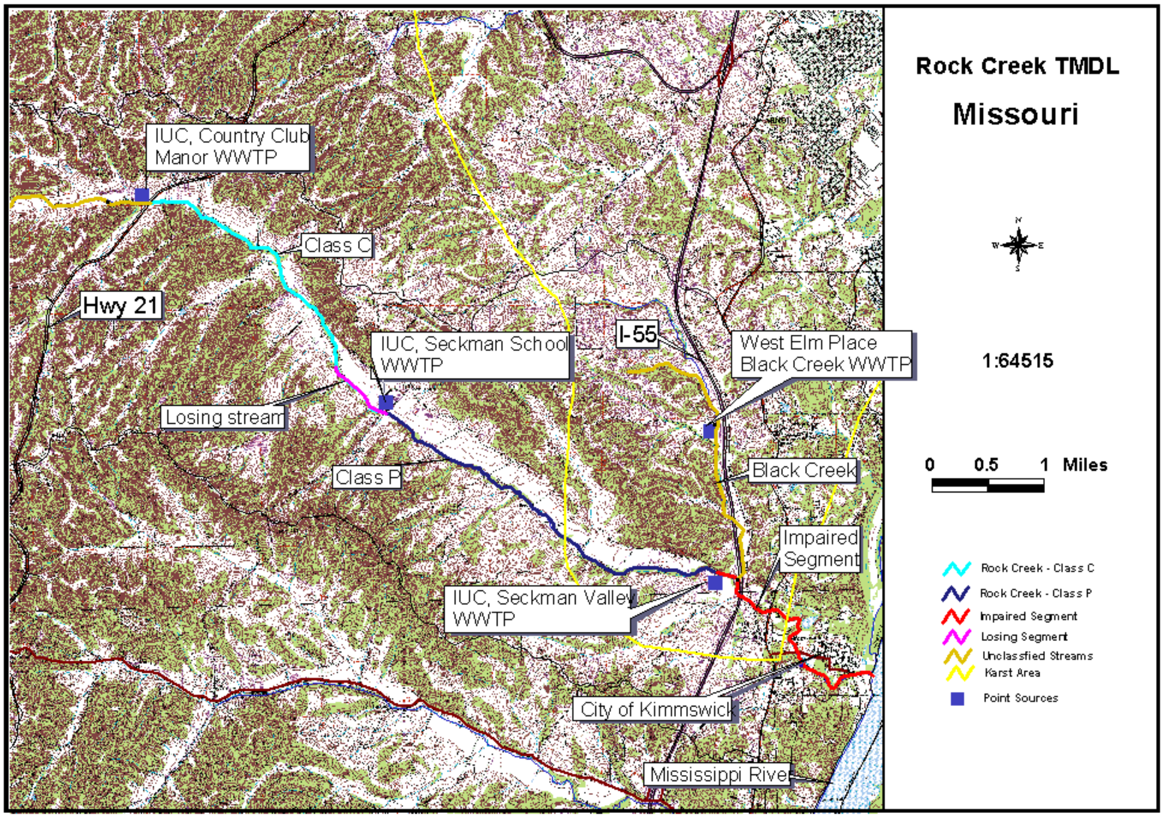
Field Data:

- April 1992, stream morphometry, streamflow and qualitative evaluation of fish and benthos, MDNR-WPCP
- July 1992, 48-hour water quality survey
- October 1992, 48-hour water quality survey, MDNR-ESP
- July 1995, 36-hour water quality survey, MDNR-WPCP
- February 1996, 36-hour ammonia decay survey

References:

- Missouri Water Quality Standards
- Standards Implementation Policy
- EPA Ambient criteria document for dissolved oxygen
- EPA Regulation 131.12
- Review of Rock Creek TMDL, Missouri

Attachments: 1. Qual2E output for West Elm Place study
2. Mixing zone provisions of Missouri's Water Quality Standards (10 CSR 20-7.031(4)(A)(5))



Rock Creek TMDL
Missouri
1:64515
0 0.5 1 Miles
Rock Creek - Class C
Rock Creek - Class P
Impaired Segment
Losing Segment
Unclassfied Streams
Karst Area
Point Sources
IUC, Country Club Manor WWTP
Class C
Hwy 21
IUC, Seckman School WWTP
Losing stream
Class P
I-55
West Elm Place Black Creek WWTP
Black Creek
Impaired Segment
IUC, Seckman Valley WWTP
City of Kimmswick
Mississippi River